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Virtual Proving Ground Distributed Test and Evaluation (DTE) Architecture Milestone 4.0 (ARCH MS 4) Focus Group Test Event: Aberdeen Test Center Contribution Summary

by Geoffrey C. Sauerborn

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14. ABSTRACT

The Virtual Proving Ground Distributed Test and Evaluation (DTE) Architecture Milestone 4.0 (ARCH MS 4) Focus Group Test Event was executed 26 January 2005 among the seven geographically distributed U.S. Army Developmental Test Command test centers. The U.S. Army Aberdeen Test Center (ATC) integrated a Test and Training Enabling Architecture (TENA) (*1*) application that correctly trans-located vehicle position from ATC to the White Sands Missile Range (WSMR) terrain. These vehicle data were not read directly from an Advanced Distributed Modular Acquisition System (ADMAS) device as was originally intended. Also, the vehicle position trans-location algorithm was embedded into the TENA application. Ideally, this trans-location service should be a data “filter” that is optionally applied to the ground truth position as it is read from ADMAS or the vision digital library system (VDLS). Further work is needed to integrate the filter translation into the ATC instrumentation data collection system as a java component. Doing so should allow ATC position coordinates to be trans-located to WSMR coordinates in the same manner that any ADMAS data channel is interpreted for display (i.e., integrated into the normal ATC data collection and presentation process). The vision TENA ADMAS system at the ATC instrumentation development team also needs to be modified to facilitate different object models (a TENA object “switch”). Following this, a direct ADMAS “read” (and translation) could be tested and be ready for future uses.

15. SUBJECT TERMS

distributed simulation; lethality; simulation interface; vulnerability

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Acknowledgments

Integrating a Test and Training Enabling Architecture (TENA) application into this exercise was done within a very tight schedule (in less than two weeks). The level of completion would have been impossible were it not for the efforts and assistance of Alan Scramlin and Anthony Docimo of the U.S. Army Aberdeen Test Center (ATC). Mr. Scramlin continues even now to work on the TENA "switch" that will facilitate future TENA object model changes and allow these revised object models to be integrated into the ATC Advanced Distributed Modular Acquisition System (ADMAS) production system. The instrumentation development team also provided the Virtual Proving Ground (VPG) team with a TENA development workstation in the Microsoft Windows[1] XP environment. Mr. Docimo had already completed the translocation algorithm and applied it during the VPG distributed test event (DTE) 4 held in August 2004. This reduced much of the work to "porting" the code into the Windows environment and integrating it with the TENA application. Gerry Hinkle and Manfred (Fred) Hartman of ATC cleared a path through network firewalls and identified computer connectivity issues, making it possible to interact with other Army test centers across the continental United States.

[1]Windows is a trademark of Microsoft.

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1. Purpose

This summary describes the recently completed virtual proving ground (VPG) architecture focus group distributed test exercise event and specifically, the U.S. Army Aberdeen Test Center's (ATC's) role, goals, and accomplishments. Possible future courses of action for ATC direction are discussed as recommendations.

2. Overview

For those who are reasonably familiar with the VPG project and its architecture focus group activities, reading section 3 and the related section 7 should be sufficient. The other sections of this document provide further details and background information. A short, high level overview VPG architecture integration evaluation is provided in section 4. ATC immediate objectives for the current integration effort are reviewed in section 5 and to what extent they were achieved is explained in section 6. Recommendations specific to ATC and more generally, distributed testing and simulation, are presented in sections 7 and 8.

3. Developmental Test and Evaluation Architecture (DTE ARCH) Milestone (MS) 4 Overview and Background

The U.S. Army Test and Evaluation Command is planning on installing a permanent, secure, distributed infrastructure capability that can be used to support test and evaluation throughout the acquisition life cycle. It is necessary to understand technical issues facing this vision. DTE ARCH integration activities are one of the means by which the Developmental Test Command (DTC) can explore distributed testing functionality provided by Test and training ENabling Architecture (TENA) and various test range resources. DTE ARCH integration efforts have three primary objectives (*2*):

1. Characterize network parameters relative to distributed testing,
2. Characterize the middleware, i.e., TENA,
3. Incorporate a broad range of test assets and characterize the object model design.

During integration of MS 4, the network could not be characterized because of a lack of resources for tools and execution. The major focus of DTE ARCH MS 4 was to gain a better assessment of TENA and application of test asset object models (objectives 2 and 3) as they support distributed testing. This involved connectivity testing and execution of a few operational test scenarios designed to exercise TENA as well as final application functionality.

DTE ARCH MS 4 was the most recent in a series of functional tests, each building upon the integration capability of the previous milestones. Earlier milestone events established each test center's basic ability to run TENA stateful (*2*) distributed objects (SDOs)[2] in a local area and wide area network environment. These were simple applications prepared by White Sands Missile Range (WSMR) personnel. Later milestones such as MS 4 involved each test center preparing their own TENA SDO that was germane to their commodity area. A U.S. Army Training and Doctrine Command (TRADOC)-based operation test scenario that is depicted in figure 1 and outlined in the test center narratives, and test execution sequence (appendices A and B) was used as a basis to drive the simulations and tools involved. More details about the scenario are given in reference (*1*).

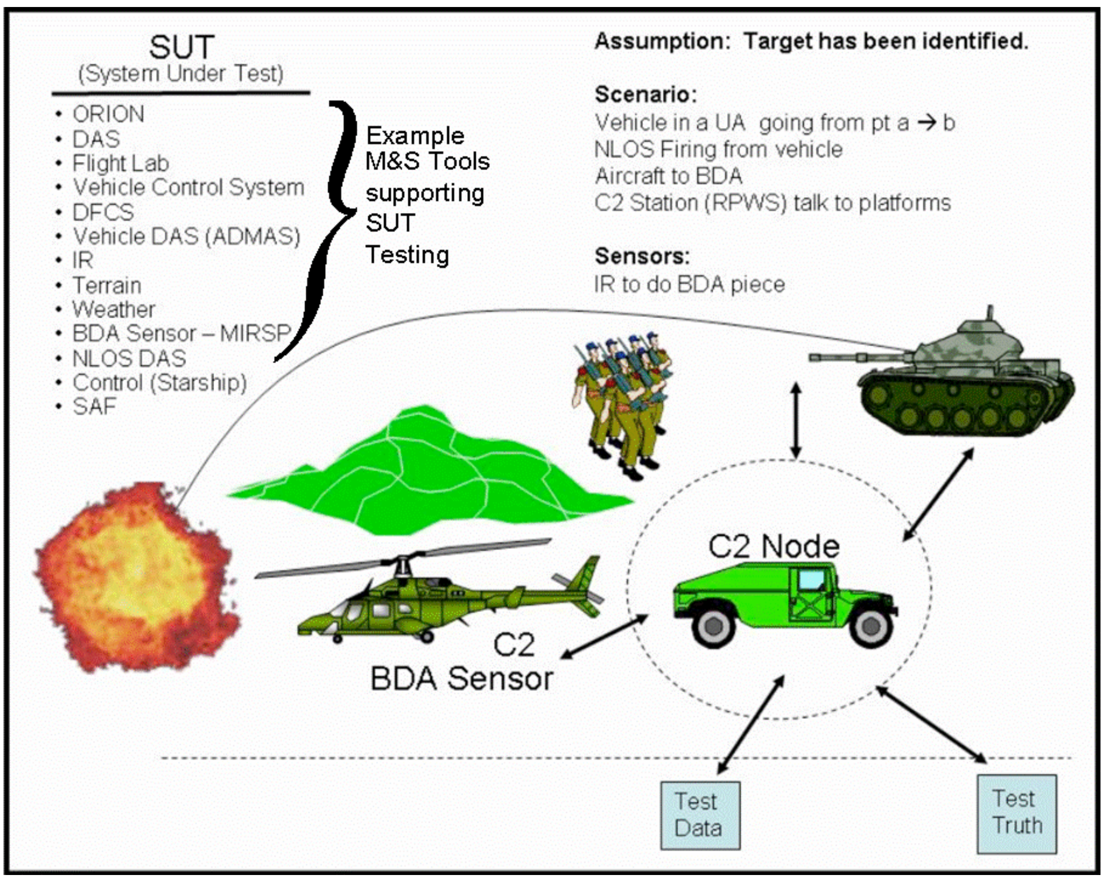

Figure 1. DTE ARCH scenario operational view (figure 1 of reference 1).

[2] SDO - a term used to describe a TENA application.

4. ATC Objectives

1. ATC was to integrate an advanced distributed modular acquisition system (ADMAS) TENA component and represent vehicle position on the WSMR virtual terrain (appendix A). Vehicle platform position would be read chiefly by the One Semi-automated Forces (OneSAF) test bed baseline (OTB) (*3*).

Other objectives that were expressed verbally (*4*) were to

2. Include global positioning system (GPS) (time synchronization) on each workstation involved. The intent was to provide a synchronized time stamp.

- ATC did not execute a time stamp because (a) a GPS timing source could not be found in time for MS 4, (b) at the time it was not clear where and in which object model (application management object [AMO] or platform object) the times stamp would or could be placed, and (c) it was not clear which application would use these data if published.

3. AMO publisher. Each application was to have an AMO integrated into its component. The AMO is an important test component that supports the requirement to know the state of all test assets all the time.

- Most test centers did not do this; instead, a separate AMO application ran on the same computer running the “main” application. ATC operated the AMO separately in this way, too, by running a separate AMO application on the same system running the ADMAS SDO.

5. ATC Accomplishments

ATC succeeded in producing a TENA platform object complete with trans-location of the Aberdeen Proving Ground (APG) position onto the WSMR terrain (the ADMAS SDO). We were not able to read these vehicle position data directly from ADMAS or the vision digital library system (VDLS). Instead, we used previously logged GPS data recorded from an ADMAS device that was mounted on a Stryker vehicle driving on the Perryman test course at ATC.

5.1 TENA Development Workstation

ATC's instrumentation development team also configured a VPG team computer as a TENA development workstation in the Microsoft Windows[3] XP environment

5.2 AMO Run From ATC

Garry Fee, Electronic Proving Ground (EPG), Arizona, developed a basic AMO publisher and made it available to MS 4 participants. This AMO SDO was run as a separate application on the same computer platform used to run the ADMAS SDO. The AMO SDO contains fields for operator point of contact information and application identifiers. The AMO also provided a simple "heartbeat" and diagnostic data designed to let the EPG "Starship" engine know the status of the local computer system. This was used as a general TENA connectivity test since each test center published and subscribed to the AMO, whereas *not* every test center subscribed to specific commodity area objects. For example, the Redstone Technical Test Center (RTTC) published a radar object that was not subscribed to by other test centers; ATC published vehicle position data within the "platform" object, which were not subscribed to by every test center.

5.2.1 Starship Run From ATC

EPG operated Starship (and a local AMO SDO for Starship) from the ATC distributed test control center (DTCC). These applications were run on a different workstation than the ADMAS SDO and ADMAS AMO.

Though not a written requirement, the ADMAS AMO SDO is intended to be compiled into and become a part of the main application which would then fill operator point of contact information and application identifier and other meta-data directly (*4*). This was not achievable within the compressed schedule; therefore, the AMO SDO was run as a separate application.

5.3 Partial Integration Into ATC's TENA Data Collection and Distribution System

Preliminary steps were made toward integrating the ADMAS SDO with the existing ATC TENA system. The existing system applies ADMAS "live feed" vehicle position information to workstations running an ADMAS SDO. However, the existing production ADMAS SDO uses a slightly different object model than the one identified for DTE ARCH MS 4. The TENA object model identified for MS 4 is shown in appendix C. The preliminary steps taken to integrate the MS 4 SDO into ATC's production environment involved creating XML tags in an ADMAS configuration file and conforming local workstation parameters to use this configuration when the TENA application is launched. This was constructed as a separate TENA naming service so as not to conflict with ATC's deployed live vehicle position display system. Further steps are

[3]Windows is a trademark of Microsoft.

required to fully integrate the new DTE ARCH MS 4 object model and trans-location. These steps are outlined in section 6.

6. Recommendations for ATC

The MS 4 ADMAS SDO is a self-contained TENA simulation component. The following options are recommendations that apply software reuse and integration into the existing production ADMAS system at ATC.

1. Complete the object model "switcher".

   This is needed to seamlessly integrate new TENA object models into the existing ATC VDLS TENA system that is used to transport position and other data for a live visual display of test vehicles on a 24-hours-per-day seven-days-a-week (24/7) basis. It is expected that future object model changes could occur, resulting in the continued need for the "switcher."

2. Incorporate the ATC-to-WSMR trans-location routine in a JAVA[4]-based VDLS data translator.

   This will provide a component that may be reused for future exercises or tests.

   This component is highly specialized for the following reasons:

   a. It incorporates a WSMR terrain (though this is read as an open flight data file, and other terrain databases could be substituted).

   b. It is specific to the Perryman test course at APG.

   Certain constants are designed into the source code, which work very well for APG. However, the farther a vehicle is from the Perryman test course, the less realistic the translation will be in terms of relative vehicle orientation. For example, a vehicle driving "north" at the Perryman test course, APG, will appear to drive "north" when translated to the WSMR terrain. However, if the vehicle originated at the Churchville test course (about 10 miles away), it would have a slight offset from true north at WSMR. The actual offset and its significance have not been quantified. The recommendation is to install this trans-location algorithm "as is" and label it as being a specific Perryman test course-to-WSMR (at some latitude/longitude) translation.

   c. It is specific to the WSMR longitude and latitude for the same reasons.

[4]JAVA, which is not an acronym, is a general purpose, high-level, object-oriented, cross-platform programming language developed by Sun Microsystems.

3. Add a WSMR map to the ATC test vehicle "viewer."

Add a map view for the trans-located area of WSMR to the current ADMAS vehicle display system. Also add a larger map for the entire WSMR.

7. Recommendations for DTE Architecture Execution (not ATC specific)

Immediately following the exercise, the author voiced these suggestions to the other test center representatives. More recommendations are expected following a complete DTC after-action review.

1. **Checklist:** A checklist of requirements should be prepared as a prerequisite for distributed test participation. This should include verification of firewall configuration. Test centers not completing these checks should be barred from participation (to allow them to focus on completing the prerequisite).

2. **Single configuration data source:** VISION[5] (Versatile Information Systems Integrated On-line Nationwide)/Army Knowledge Online, or another central location should be used to upload the most recent version of important documents (such as firewall configuration). During MS 4, some documents were distributed via e-mail, and some resided on VISION. This added to the confusion. As an example, ATC was operating from a stale document resulting in a misconfigured firewall.

8. Conclusions

The ADMAS SDO was very successfully integrated into MS 4. ATC also faithfully populated the platform object with time space position information (TSPI). Other test centers were only able to fill platform TSPI with "test data" that were geographically meaningless. The TENA-compliant OTB was able to view our vehicle operating on top of the WSMR terrain surface. This was an accomplishment since OTB will not display entities on its viewer if they have miscalculated coordinates resulting in locations "off the map." Considering the short development time (approximately two weeks), this can be viewed as highly successful.

With a similar amount of effort, the trans-location algorithm (specific to ATC-WSMR) can be properly integrated into ATC's production system for future reuse. Adding more general worldwide trans-location capability would take a little more time.

[5] http://vision.atc.army.mil/

9. Epilogue

DTE ARCH MS4 was another stepping stone toward the development of a distributed test capability across U.S. Army Test and Evaluation Command (ATEC). Eventually, there should be a matrix of test range and simulation assets organized into a Department of Defense (DoD) architecture framework to better enable test customers to map their requirements to existing and needed simulation test environment capabilities. This work began with the VPG project within DTC. From DTC, it grew to receive participation from the other Army Test and Evaluation Command subordinate commands (Operational Test Command and Army Evaluation Command).

Since the inception of VPG, the DoD has issued Joint Vision 2020. In this strategic planning guidance (SPG), the need for a framework to describe test capabilities as well as the requirement stating that a "persistent, robust modern networking infrastructure for systems engineering, developmental test and evaluation, and operational test and evaluation (OT&E) (including initial OT&E (IOT&E)) must be developed that connects distributed live, virtual, and constructive (LVC) resources" (*5*). The cross-command collaboration effort (3CE) is an Army project between ATEC, RDECOM, and TRADOC with many of the Joint Vision 2020 objectives. A DoD Joint Projects Office (JPO) T&E project that supports these objectives is currently in the feasibility study phase this year. This project is initially called the Joint Test and Evaluation Methodology (JTEM). Many current VPG architecture and other efforts are being aligned with 3CE. For example, the VPG Synthetic Environment Focus Group Distributed Test Event-5 (DTE-5) that is being concluded August-September 2005 is highly integrated with many 3CE activities. VPG will continue to coordinate and cooperate with 3CE, JTEM, as well as other efforts.

Following DTE ARCH MS4, an after-action review took place (February 2005). Each of the test centers contributed with a report detailing its own focused lessons relating to its activities. That final report combining all test center perspectives may not ever be produced because of accelerated DTE-5 and 3CE architecture activities. Therefore, this report is being published to separately document activities from an APG perspective and attempt to make the reader aware of some of the broader issues.

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Appendix A. ATC Objectives (and other test center narratives)

These are the narratives provided by VPG architecture focus group POCs from each test center. Some are labeled event 2.5, yet were still applied for event 4.0 (this experiment).

ATC objectives:
(ATC Narrative)

1. Scenario Narrative. ATC will provide live test data collected on an Aberdeen Test Center driving course to support the DTE-ARCH scenario. This data will represent an individual FCS vehicle surrogate maneuvering in open, flat terrain. The source data will be derived from a live test run. For this reason, the FCS vehicle surrogate mission will be scripted. The APG platform will represent a non-combat vehicle operating along a resupply route to support the NLOS battery. OTB will subscribe to and visualize the platform object and attribute updates which are translocated to WSMR coordinates and published through the ATC ADMAS server.

DTE-ARCH Narrative
FlightLab – Event 2.5

In event 2.5 ATTC will use FlightLab to simulate a Blackhawk helicopter. The purpose of the Blackhawk helicopter in this exercise is to perform BDA and will involve the following steps.

1. The Blackhawk will initially be stationed at a predetermined location on the battlefield.

2. The target's location will be provided prior to the event.

3. When the target has been fired upon, C2 Vehicle will provide a verbal message to FlightLab to commence flying to target and performing BDA which will be done by attached DIRSP.

4. During event 2.5 FlightLab will publish TSPI info (position, velocity).

5. In event 4 FlightLab will publish AMO info and subscribe to wind speed and direction from Wind localclass, target location from SensorContact message, and time of fire from Cannon message. Some may be implemented but not promised by event 2.5.

DTE-ARCH Narrative
EPG Fort Huachuca – Event 2.5

In the Milestone 2.5 Event, EPG will provide an Application Management Object (AMO) publisher application and subscriber application for use at all participating test sites. The AMO publisher will emulate the eventual functionality (slated for Milestone 4), in which all participating applications will publish an AMO. The AMO subscriber will emulate functionality served by Starship (slated for 1 February).

During the 2.5 Event:

- Each site runs an instance of the AMO Publisher Emulator application;
- Those sites who wish to subscribe to the AMO publication will run an instance for the AMO Subscriber Emulator application;
- The objective is for participating site's AMO Subscriber Emulator application to see the published AMOs from all other sites.

DTE-ARCH
DIRSP Component

For the DTE-ARCH event, the DIRSP scene generation capabilities will be used to simulate a sensor mounted on a Blackhawk helicopter. The sensor will perform a battle damage assessment role. Inputs will include platform and target TSPI updates. The sensor will be controlled by an operator using a joystick. When the target is centered in the crosshairs, a trigger pull event by the operator will prompt the publishing of target position data.

WDTC (*West Desert Test Cell*)
DTE-ARCH milestone participation for Dugway Proving Grounds (DPG), Utah

Milestone 2.5: DPG will provide wind information consisting of direction and speed for a given position. Wind direction will be given in the form of degrees and wind speed will be measured in kilometers per hour. The weather information provided will cover White Sands from the location of latitude 32.05 north, longitude 106.62 west and will cover approximately 60 km2. Weather data will be provided at one kilometer of resolution with thirty-five levels of elevation.
Weather data provided for this exercise will be prerecorded and will likely be data from the August/September timeframe of 2003.

Milestone 4.0: DPG will participate in the same manner for milestone 4 as it did for 2.5 and further provide site application information through the InterTec AMO model.

DTE-ARCH Narrative
WSTC – Event 2.5

In event 2.5 *(White Sands Test Cell)* WSTC will simulate the injection of a live asset (DFCS target) into a simulation exercise DTE-ARCH. WSTC will build a TENA application that will publish a Platform Object Model (OM), Application Management Object (AMO) and subscribe to a Cannon OM to determine casualttyAssessmentStatus. The purpose is an exercise in live/virtual/constructive environments. WSTC's approach will involve the following steps.

6. The WSTC application (LiveTarget) will publish the AMO on startup. For this exercise, the update rate on the AMO will be at a 1 per second rate.

7. The target's location will be static (non-moving) during the exercise. The LiveTarget application will begin publishing the Platform OM soon after startup. The Platform OM will be updated at a 1 per second rate.

8. The LiveTarget application will subscribe to the Cannon OM.

9. Upon receipt of a Cannon OM update, the LiveTarget application will change casualtyAssessmentStatus from ALIVE to KILL_CATASTROPIC.

10. Upon completion of the event, all publications will cease.

In addition to the LiveTarget application, WSTC will help in the coordination & planning of the event. WSTC is researching other applications (3D viewers, gateways, and such) that might be brought into the exercise.

DTE-ARCH Narrative
YPG Cannon OM

The cannon will receive “targeting information” from the controller. On receipt of the targeting data, the Cannon model will process that data and the gun will be “aimed”. When the gun position receives the “firing clearance”, the gun can be fired at the target. After the weapon fires, the data for chamber pressure, muzzle velocity, and time of fire will be returned to the subscribers.

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Appendix B. Test Scenario Sequence

This test scenario sequencing shown in table B-1 defines the order in which SDOs were to join and execute certain tasks (6). In actuality the join order had to be modified by experimentation because of connectivity problems. These problems resulted in applications being suspended (or "hanging", being paused while waiting for a TENA method to return control to the calling application). By trial and error and by eventually solving most of the firewall issues a successful application launch sequence was determined.

Reasons for applications "hanging" were not immediately determinable. A variety of factors contributing to this are discussed:

A). Improperly configured firewalls.
B.) Applying the TCP/IP reliable communication option for TENA data transport
This could result in waiting for a response and eventual time-out when connectivity is disrupted.
C.) Differences in the TENA transport option used by each application.
For example there was not a constant use of the return path option: -ORBlistenEndpoints iiop://aaa.bbb.ccc.ddd:portNum. This also relates to firewall configuration since some firewalls will block data returning from a different port. It was agreed that each test center would specify the port for the received data via the TENA ORBlistenEndpoints option but few did.
D.) Differing network options and operating systems configurations applied by the various computers involved. The was a mixture of Linux, Microsoft windows 2000, and Microsoft windows XP operating systems. By default XP systems implement a local firewall. There were also differences between distributions within those systems that may have had an impact. For example Microsoft service pact 2 (SP2) has modified windows in the following ways (7):

1. TCP packets may no longer be sent through the raw sockets API
2. IP "spoofed" UDP packets may no longer be sent through raw sockets (affects decoy and spoofed scanning).
3. Outbound TCP connection attempts are artificially reduced to a slow rate. Apparently this is done to prevent scanning of ports. This could be effecting the TENA communication as the application looks for an available port.

Table B-1 Formatting Notes:
Example 1: "AMO-STARSHIP" means the AMO object from the Responsible Application of "Starship."
Example 2: "CANNON-TARGET" means the CANNON object from the Responsible Application of "target."

Table B-1. DTE ARCH Milestone 4, Test Scenario Sequence (source: reference 5).

Step	Action	Publisher	Subscriber
1.	Test is initiated. All applications up and running.		
2.	Applications status check, STARSHIP TARGET ADMAS CANNON 4DWX FLIGHTLAB RADAR DIRSP OTB	AMO-STARSHIP AMO-TARGET AMO-ADMAS AMO-CANNON AMO-4DWX AMO-FLIGHTLAB AMO-RADAR AMO-DIRSP AMO-OTB	AMO- STARSHIP
3.	OTB subscribes to Target, ADMAS, Cannon, FlightLab, Radar and DIRSP.	PLATFORM-TARGET PLATFORM-ADMAS PLATFORM-CANNON PLATFORM-FLIGHTLAB PLATFORM-RADAR PLATFORM-DIRSP	PLATFORM-OTB
4.	4DWX publishes wind information to FlightLab for the duration of this scenario.	WEATHERSERVER-4DWX	WEATHERSERVER-FLIGHTLAB
5.	ADMAS publishes live test data to Radar, and OTB for the duration of the scenario	PLATFORM-ADMAS	PLATFORM-RADAR PLATFORM-OTB
6.	A target is placed at WSMR.	PLATFORM-TARGET	
7.	C2Vehicle sends a VERBAL command to Radar to commence target searching.		
8.	Radar searches		PLATFORM-RADAR
9.	Radar Locates target	SENSORCONTACT-RADAR	PLATFORM-OTB
10	Radar sends target VERBAL position data back to C2Vehicle		
11	C2Vehicle sends VERBAL targeting data to Cannon.		
12	Cannon receives targeting data and aims cannon at target.		
13	When given clearance by C2 Vehicle, Cannon fires.	CANNON-CANNON	CANNON-TARGET
14	After Cannon is fired, an acknowledgment is sent to C2Vehicle		CANNON-TARGET CANNON-OTB CANNON-FLIGHTLAB
15	Cannon data is sent to FlightLab and OTB.	PLATFORM-TARGET	PLATFORM-FLIGHTLAB PLATFORM-OTB
16	C2Vehicle sends a VERBAL message to FlightLab to commence flying to perform target BDA.		
17	DIRSP identified the target.	SENSORCONTACT-DIRSP	
18	DIRSP provides range and position information back to FlightLab.		PLATFORM-FLIGHTLAB
19	FlightLab sends VERBAL Battle Damage Assessment results back to C2Vehicle.		
20	End of Scenario		

Appendix C. DTE ARCH MS 4 Object Model

Figure C-1 displays the DTE ARCH MS 4 object model that includes the InterTech AMO object model. Not shown is the ILH object model and its components.

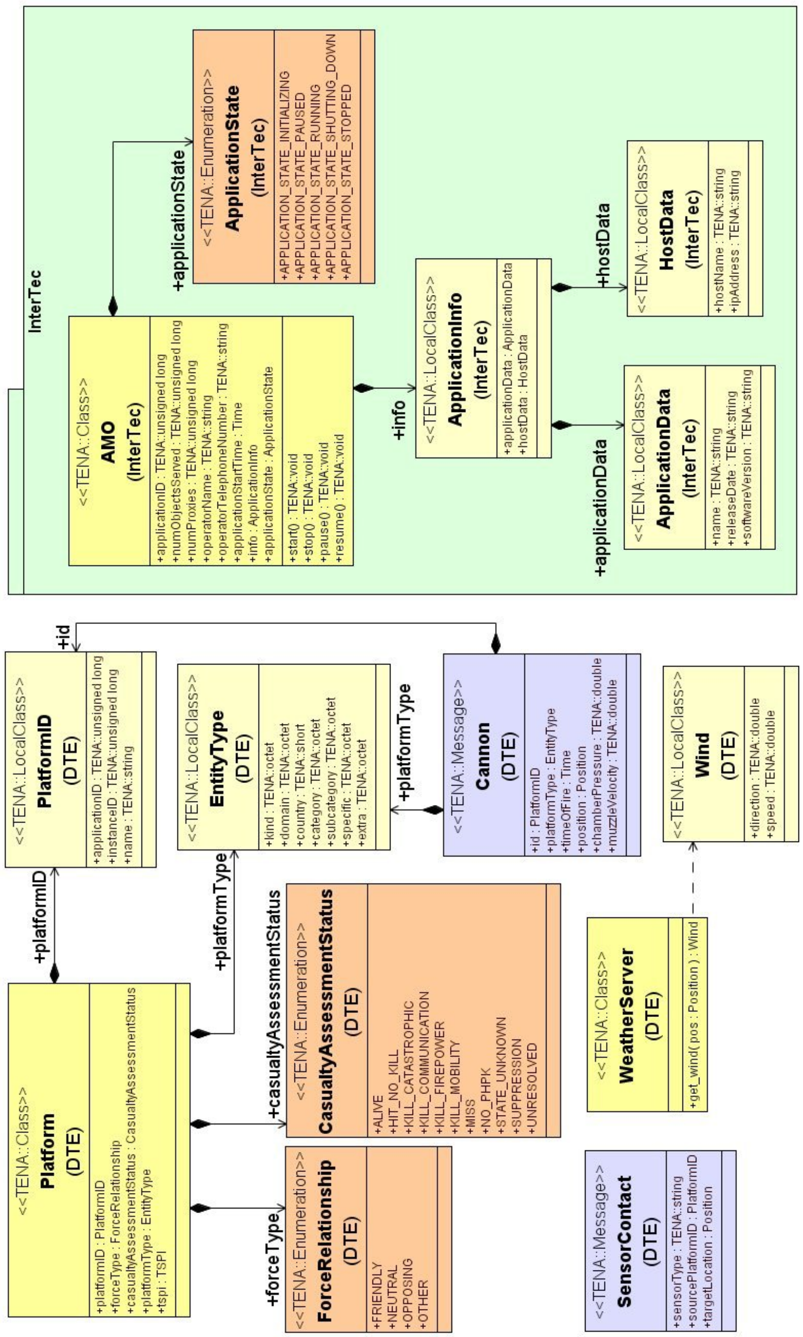

Figure C-1. The DTE ARCH MS 4 object model.

The ILH object was not directly addressed in the report body since ATC did not incorporate it into the ADMAS SDO. Its purpose is to provide the means to tag simulation and test data to assist in its storage and creating an automated archive reference to these data in the vision digital library system (VDLS). The VPG is largely a product of the VPG's Integrated Information Systems (IIS) Focus Group. The ILH data model is incorporated in the VLDS data structure. The TENA ILH SDO developed by the RTTC and allows an operator to fill ILH fields to avoid mistakes when test or test supporting simulation data are stored and their references registered in the VDLS.

The objective goal is to have this type of automated data archiving support built into M&S test range assets. More on the ILH and its implementation at RTTC is described elsewhere (8).

Appendix D. Coding the ADMAS SDO

This appendix describes the software coding used to implement major componts of the ADMAS SDO.

Introduction

Coding of the TENA platform object was complete to include the APG position translocation to the WSMR terrain. This final product is called the ADMAS SDO. Even though this was called the ADMAS SDO, it was not actually reading live position updates from an ADMAS vehicle telemetry device. Instead the ADMAS SDO had its input designed to read vehicle position (GPS) updates in a format available from ADMAS. ADMAS GPS output was recorded during a previous live exercise, the distributed test event 4 (DTE-4) experiments. These captured DTE 4 data were recorded from a live Stryker vehicle on the ATC Perryman test track. The overall DTE 4 experiment is described elsewhere (*9, 10, 11, 12*).

The vehicle translocation algorithm applied was developed by Mr. Anthony Docimo, ATC, during DTE 4 (*13*). This algorithm provided very good results for the specific conditions used (translating vehicle position and orientation from APG to the WSMR).

Objectives for a future ATC ADMAS system should include improving on the MS 4 implementation in two aspects:

1) A general translocation algorithm should be developed for any two world ground positions.
2) The ADMAS SDO should be integrated into the ATC instrumentation and data archiving process in order to both read and translocate data directly from the vision digital library system (VDLS), and to read ADMAS GPS data from a live vehicle feed. Reading live vehicle data could be done by using the existing ATC Ground systems TENA object (not compatible with the DTC ARCH MS 4 object model (Appendix C)) or by creating a TENA object model that bridges the two object models. There are many other bridging solutions including publishing the data on to a LAN between distinct applications (*13*). The best solution depends on latency, project resources, and other constraints.

Coding

The ADMAS AMO was created on the TENA development workstation that was configured on a Windows XP computer with the remarkable technical assistance of ATC's instrumentation team. All directories and files referenced are relative to their location on that that windows XP computer. A backup of all the files was created prior to the MS 4 event and is located in the author's personal workspace on the vision digital library system (VDLS) (http://vision.atc.army.mil).

TENA auto-generates all necessary underlying middleware required for SDO's to communicate with the "logical range" (TENA simulation environment). These software modules are code "stubs" in that they provide the interface to the publish data to and read data from the object model. It is up to the programmer to implement the correct behavior that goes into these modules. Most of the TENA middleware was applied as-is. However, scientists at the Aberdeen Test Center (principally Mr. Alan Scramlin) had designed an improvement in the call back methods to the TENA IKE version 3 release. This improvement was implemented from the necessity of operating with vehicle telemetry being received 24/7. After prolonged operation the middleware would become locked. This issue and ATC's callback redesign was made known to the TENA developers. Specifically this involved applying standard template library (STL) maps instead of lists and disabling the default callback process. As mentioned TENA provides most middleware source code, however to implement the ATC improvements, seven middleware source code files are modified. They are all of the basic implementation (BasicImpl) class, the source files are:

CallbackInfo.cpp
DestructionCallbackFactoryImpl.cpp
DestructionCallbackFactory.cpp
DiscoveryCallbackFactoryImpl.cpp
DiscoveryCallbackFactory.cpp
StateChangeCallbackFactoryImpl.cpp

Further technical details are not within the scope of this report. However, it is mentioned here because the ADMAS SDO used the ATC callback system to be most compatible with ATC's instrumentation and data collection processes. A user application will not be effecting in that it will interface to the same API.

Main Platform Application

The main body of source code may be found in the directory:

C:\TENA\ObjectModels-v4.0.4\Windows-XP-VC++-7.1-opt-mt\wsmr-DTE_ARCH_FULL-v1.2_Impl\main\

Files:

```
publish_DTEPlatform.cpp
publish_init_DTEPlatformAttributes.cpp
```

These read vehicle position updates, transform them to the required coordinates and publish the vehicles state change. Publish_init_DTEPlatformAttributes.cpp contains the main initialization function (initServant()). This is used to initialize the entity type and other attributes as the code portion displayed in figure D-1 shows.

publish_DTEPlatform.cpp:

```
DTE::DTEPlatform::ServantPtr pDTEPlatformServant(
  pServantFactory->createServantUsingDefaultFactory() );

  initServant(  pDTEPlatformServant );
```

Figure D-1. Initializing pDTEPlatformServant, the TENA ADMAS platform object.

After initialization, the platform object merely continues to receive position by polling them periodically from pseudo ADMAS interface. They are automatically translocated to be on the WSMR location when obtained from the ADMAS interface. The translocation algorithm developed by Docimo (*14*) was wrapped into a self contained routine. Docimo's application ran in the Linux environment and used shared memory and sockets. Shared memory and socket calls were left intact and commented out via C-language param statements:

```
#ifdef _USES_SHEM
```

The rest of the algorithm and open flight terrain query libraries were ported to the WIN32 environment with very few problems. The few minor changes that were required were embedded within

```
#ifdef WIN32
```

C-language param statements. These modified files are located in the `c:\admas\conv\ folder` and changes where made to the source code files:

```
dte4_leg1.c
trQuery.c
terrain.c
terrain.h
win32_gettimeofday.c
win32_gettimeofday.h
```

`win32_gettimeofday.c` *(added)*
`win32_gettimeofday.h` *(added)*

INTENTIONALLY LEFT BLANK

List of Acronyms

3CE	cross-command collaboration effort
ADMAS	advanced distributed modular acquisition system
AMO	application management object
APG	Aberdeen Proving Ground
ATC	Aberdeen Test Center
ATEC	U.S. Army Test and Evaluation Command
DoD	Department of Defense
DTC	Developmental Test Command
DTCC	distributed test control center
DT&E	development, test, and evaluation
DTE-ARCH	Distributed Test and Evaluation Architecture
EPG	Electronic Proving Ground
GPS	global positioning system
JPO	Joint Projects Office
JTEM	joint test and evaluation methodology
LVC	live, virtual, and constructive
OT&E	operational test and evaluation
OTB	OneSAF test bed baseline
RDECOM	U.S. Army Research, Development and Engineering Command
RTTC	Redstone Technical Test Center
SDO	stateful distributed object
SPG	strategic planning guidance
T&E	test and evaluation
TC	test center
`TENA	Test and Training ENabling Architecture
TRADOC	U.S. Army Training and Doctrine Command
TSPI	time space position information
VDLS	vision digital library system
VPG	Virtual Proving Ground
WSMR	White Sands Missile Range

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